DOCUMENT RESUME

ED 047 729 LI 002 609

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TITLE	A Framework for the Evolutionary Development of an Executive Information System. Part I. Organizational Problem-Finding.
INSTITUTION	Mitre Corp., Bedford, Mass.
SPONS AGENCY	San Mateo County Superintendent of Schools, Redwood City, Calif.
REPORT NO	M68-11
PUB DATE	Jun 70
NOTE	73p.
EDRS PRICE	EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS	Information Science, *Information Systems, Management Education, *Management Systems, Organization, Planning, *Problems, *Systems Development
IDENTIFIERS	*Management Information Systems, PEP, Prepare Educational Planners

ABSTRACT

This document, part one of a two-part report, on the development of executive information systems was distributed to the California Educational Administrators participating in the "Executive Information Systems" Unit of Instruction as part of the instructional program of Operation PEP (Prepare Educational Planners). The framework described in this paper provides a comprehensive outline of the efforts involved in Management Information Systems' (MIS) evolutionary development. The particular focus in this part is on organizational problem-finding. The conceptual framework scopes the process of MIS planning and development, from need recognition to evolving MIS operational capabilities. An outline of the steps in MIS development is identified and the discussions associated with these steps indicate how the problem-finding and subsetting process can be tailored to the time and funds available. (Author/SG)

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Report M68-11

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A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT OF AN EXECUTIVE INFORMATION SYSTEM.

Part 1. Organizational Problem-Finding

(1) J.A. Evans

(5) June 1970

This paper has been especially prepared for distribution to the California Educational Administrators participating in the "Executive Information Systems" Unit of Instruction as part of the instructional program of OPERATION PEP (Prepare Educational Planners).

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PREFACE

Redwood City, Calif.

Under a (1968) contract with the San Mateo County (~~California~~) Superintendent of Schools, the Information Systems Division of The MITRE Corporation, in conjunction with the staff of Operation PEP* (Prepare Educational Planners), prepared a three-day Unit of Instruction on Executive Information Systems. The purpose of the course, presented in June 1968, was to support Operation PEP in its efforts to introduce some basic concepts of information systems technology to California Educational Administrators.

The presentations included in the Unit of Instruction were augmented by several reports. Three supplemented the discussions by providing general background material. The remainder, prepared as companion handouts for the individual presentations, contained copies of the visual aids (diagrams) used to emphasize significant concepts.

The present (1970) contract between the San Mateo County Superintendent of Schools and The MITRE Corporation calls for the documentation of the concepts illustrated in those diagrams and for the reissue of the supplementary reports. The objective is to provide, in one package, a complete set of references which can be used by Operation PEP in its over-all instructional program. The contents of the package, which consists of eight reports, are identified in the following list.

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* Operation PEP is funded by a U.S. Office of Education Grant Award under Title III of the Elementary and Secondary Education Act of 1965 (P.L. 89-10).

SUPPLEMENTARY REPORTS

Digital Computer Principles

J. D. Porter

Input-Output Trends

J. Mitchell

Digital Simulation and Modelling

G. B. Hawthorne, Jr.

UNIT OF INSTRUCTION REPORTS

Information System Overview

J. H. Burrows

The State-of-the-Art in Information Handling

J. K. Summers and
J. E. Sullivan

A Framework for the Evolutionary Development of an Executive Information System (in two parts)

J. A. Evans

Persistent Problems in System Development

J. H. Burrows

An Information System for a District School Administrator

S. G. Lewis

Collectively, these reports provide a basic overview of information system technology; individually, they focus on some of the specific aspects associated with the design, development, implementation, and use of information systems.

A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT OF EXECUTIVE INFORMATION SYSTEMS

PART I ORGANIZATIONAL PROBLEM-FINDING

The authors of the other papers in this series* explicitly or implicitly stress the need for management's involvement in the planning and development of formal[+] information systems. Their reasons, based on experience, are varied and solid. More important, their recommendation is not unique. A conference[±] of system professionals, held less than 10 days after the Operation PEP Unit of Instruction on Executive Information Systems, was separated in time but not in viewpoint. Those who attended the conference stress that management involvement is critical because, among other things, no viable theory of management information system exists today.

Top management's seeming detachment can, in part, be attributed to the historical emphasis in information systems: preoccupation with data processing

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*See entries under Unit of Instruction Reports in Preface.

+As defined by J.H. Burrows in "Information System Overview" (see Preface), formal information system means computer-based information system.

±Held at Carnegie-Mellon University, Pittsburgh, in June 1968. Proceedings to be published in the Fall, 1970, by Prentice-Hall, Inc., under the title Management Information Systems: Progress and Perspectives; J. T. Heames, C. H. Kriebel and R. L. Van Horn (eds.).

Data: *raw statements of fact.*

Information: *insights provided by interpretation of data.*

Problem: *the difference between what exists and what is desired.*

As a matter of discipline we should probably think of every system as a subsystem, and during the design of a subsystem we should force ourselves to think of its relationship to some bigger system of which it is a part.

J. M. Salzer,
Evolutionary Design of Complex Systems

rather than with management decision-making processes. Thus top management often delegated to lower-level managers the responsibility for guiding system development — managers with a functional bias (for example, marketing) who worked with system professionals with a computer subsystem bias (for example, hardware). This led to a mismatch between needs and technological aids. Both groups were overly concerned with the processing speed and manipulability of data rather than with the type of data required to support the needs of all managers. Failure to recognize the information system as a subsystem of the larger organizational system may have simplified the design effort but it certainly diminished the ability of the former to support the latter. The result today is a painful recognition by both managers and system professionals that while good data processing systems are necessary to good management systems, the relationship is one of dependency and not inevitability.

The identification of requirements for the Management Information System (MIS) is the responsibility of the manager. He can hire consultants with specialized skills to help him, he can guide their efforts and integrate the results of their studies, but he cannot delegate his expertise and insights —— and thus his responsibility —— to any outsider no matter how capable. To do the job properly the manager first must acquire a systems perspective of his organization and the collective dynamic processes within it. He must replace the familiar organization chart with a conceptual delineation of the maze of integrated but separable subsystems that really are the organization. He then can begin to understand how the actions within and among the units (subsystems) relate to and impact upon each other and on the organization as an entity.

This two-part paper provides a conceptual framework that scopes the process of MIS planning and development, from need recognition to evolving MIS operational capabilities. Part 1 is of direct concern to the manager because it focuses on organizational problem-finding,* a subject little discussed in the literature yet crucial to MIS development. A comprehensive outline of the efforts involved in MIS development is identified and the discussions associated with the various steps indicate how the problem-finding and subsetting process can be tailored to the time and funds available.

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*The growing need for the manager to do a better job of problem-finding is discussed by W. F. Pounds in "The Process of Problem Finding," Industrial Management Review, 11, Fall 1969.

. . . In the ever-renewing society what matures is a system or framework within which continuous innovation, renewal and rebirth can occur . . . (Author's Italics)

John W. Gardner,
Self-Renewal,
New York, Harper & Row, 1965

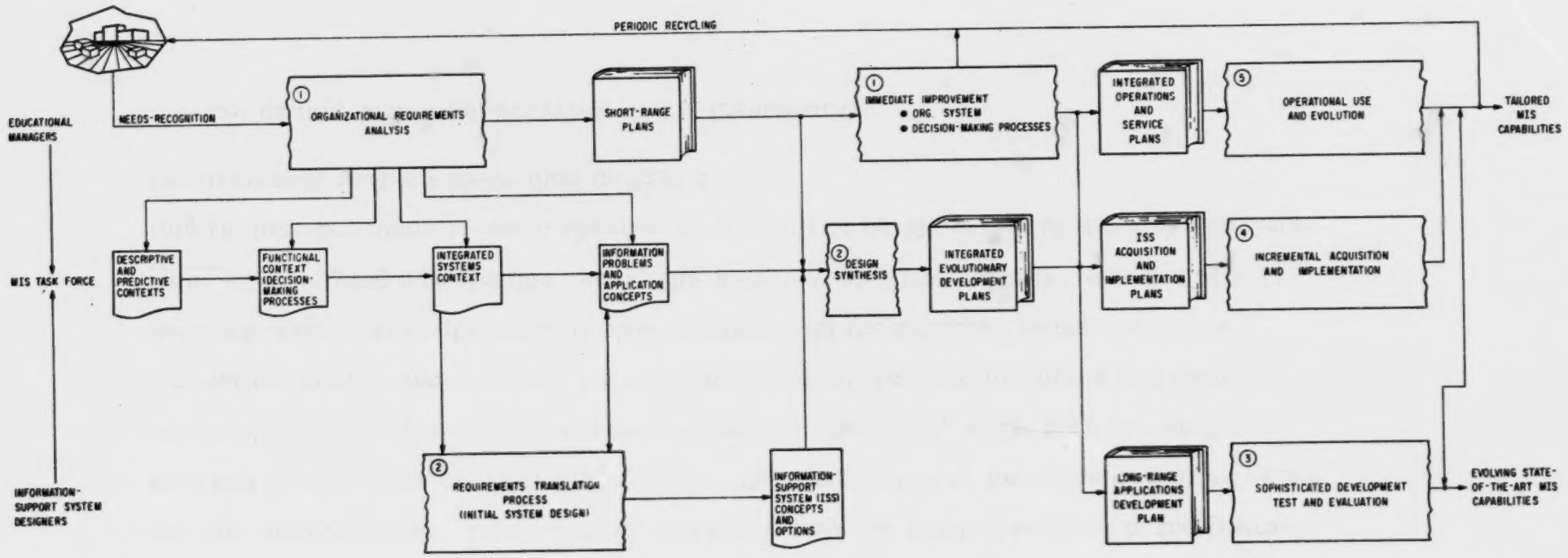
Using organizational requirements analysis as the vehicle for problem-finding, the framework allows the manager to establish contexts that will provide him with three different perspectives of his organization: as a static entity, as a network of dynamic processes, and as an integrated system. These contexts determine the degree of emphasis placed on subsequent analysis efforts. Another feature of the framework is that it encourages the manager to establish some of these contexts before he defines organizational missions, goals and objectives. This is done because the complexity and interdependency of social-economic institutions make it difficult to structure such statements of direction out of context.

Part 2 focuses on information system acquisition, implementation, and operational use and improvement. This process, while complex, is much discussed in the literature and so activities are only highlighted. The responsibility for these activities rests primarily with the information system designers. However, while they can structure alternative application concepts for the solution of information problems and estimate the costs associated with each, it still remains with the manager to determine the value of satisfying a particular need. His judgment about the relative value of alleviating various problems is much sharper as a result of participating in the organizational requirements analysis described in Part 1.

Let us now turn to an overview of the framework.

EXECUTIVE INFORMATION SYSTEMS

A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT



Efforts Defined by Framework

① Organizational Requirements Analysis
② Information System Design and Planning Documentation
③ Information System Development, Test and Evaluation
④ Information System Acquisition and Implementation
⑤ Operational Use and Improvement of Information System

The conceptual framework (see opposite Chart) defines five major efforts (see circled numbers), and the relationship of those efforts to key products, for example, to contexts and plans (detailed documentation). The efforts are depicted as separable and each product generated as clearly relatable to a specific effort. Admittedly, this is an oversimplification of a process that, in actuality, is very complex. However, this paper does not contain a "cookbook" approach to the "x" number of procedures involved in planning and developing MIS capabilities. Its purpose is to communicate to educational managers a structured approach to thinking through organizational problem-finding (emphasis of Part 1) so that they will be better able to understand the recommendations of the information-support system design team and guide their efforts in acquiring MIS* operational capabilities (emphasis of Part 2). In this respect, the conceptual framework serves as a useful means of communication.

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*In this paper MIS is used as a synonym for EIS (Executive Information System).

As shown in the Chart, the efforts are assigned to one of three major streams in order to align them with the groups primarily responsible for carrying them out. Thus efforts and products identified along the upper stream are the concern of educational managers, those along the lower stream of information-support system designers, and those along the middle stream of the MIS Task Force (discussed below). The educational managers are depicted as having primary responsibility for initiating the MIS development effort, for leading the organizational requirements analysis, and for implementing immediate improvements, that is, those improvements that may not require MIS capabilities (discussed later). Thus, the manager's efforts are directed toward organizational problem-finding in order to derive the contexts and concepts which later can be translated into information-support system design alternatives. The application concepts become the inputs to the design synthesis effort, which is used as the bridge between Parts 1 and 2 of this paper. The option(s) selected for acquisition as a result of design synthesis (outputs) determine the contents of the integrated plans that guide the development, installation, operation and improvement of an evolving set of MIS capabilities.

The information-support system design team, which frequently includes outside consultants, is primarily responsible for conception and design of information-support system options and for providing assistance in the identification of MIS applications for long-range development, test and evaluation. Their efforts are guided by the integrated plans developed by the MIS Task Force.

The MIS Task Force includes the educational managers and information-support system designers identified above. Their participation is flexible or on an "as needed" basis. The permanent element of the MIS Task Force is a steering committee composed of top management within the organization. This committee provides continuity and guidance to the over-all effort.

The Task Force is the focal point of the MIS development effort. Early in the process it is responsible for guiding the development of the products (the contexts) of the organizational requirements analysis. These contexts are critical as a

means of communicating an understanding of the organization to the information-support system design team. Effective dialogue among professionals with unique jargons will ensure relevant matching of needs (as opposed to desires)* to information-support system options. Its most critical contribution is realized during design synthesis when key decisions must be made regarding the cost and value of various design options.

During the latter stages of MIS development, the Task Force's prime responsibility shifts to a complex but well-understood process: efficient acquisition and implementation of MIS capabilities. These efforts are aimed at alleviating the problems identified by the organizational requirements analysis. If the former efforts are not properly carried out, the Task Force may find that it has authorized the expenditure of substantial funds to improve what is basically a misinformation system.

*This subtle point is discussed by J. H. Burrows, op. cit. (see Preface).

While efforts move forward over time, the conceptual framework does allow for the refinement of selective aspects of the analysis effort at two points: as immediate improvements are introduced into the organization and following operational use and evaluation of MIS capabilities. Again, this is an oversimplification because in practice efforts shown as separable are conducted concurrently and the results recycled as necessary rather than at given points. Such unscheduled recycling of data can lead to problems of mismatch between requirements and capabilities unless the modifications introduced on the basis of the more refined results are compared with statements of requirements. For example, an immediate improvement in, say, organizational form (recombining similar activities formerly distributed over several organizational units) may impact on requirements and hence on the MIS capability recommended. Coordination (integrated planning) therefore represents an important unstated requirement in any evolutionary MIS development effort.

The following pages provide an overview of the steps in organizational requirements analysis, the mechanism used for organizational problem-finding.

Organizational Requirements Analysis

- **Constraints and Focus**
  Steps 1, 2
- **Operational Environment and Mission**
  Steps 3, 4
- **Functional Analysis**
  Step 5
- **Development of Integrated Systems Context**
  Step 6
- **Translation of Information Problems into Requirements**
  Step 7
- **Recycling**
  Step 8

Organizational requirements analysis is an extremely complex procedure requiring innovative tailoring of the systems approach blended with insights acquired from other disciplines. Its complexity is governed by the nature of the organization being analyzed: for example, analysis of social-economic organizations is usually much more complex than that of a business because, among other factors, public opinion impacts on their goals in a more direct way.*

*The relation of goals to information systems is discussed under Step 4.

A basic understanding of the analysis process can be communicated by discussing it in terms of eight major steps (see facing page). The first two steps concentrate on determining the scope of the analysis and selecting the management level* which is to be the organizational core system used as the focal point of the requirements analysis. In large, complex organizations such bounding is extremely important in order to keep the analysis effort manageable. During this phase some initial assumptions are made about the political environment, the availability of appropriate interdisciplinary skills from the "hard," "soft"** and information sciences, the degree of management support, and the scope of the analysis versus constraints of time and money available.

Steps 3 and 4 focus on "seeing" the core system in relation to its internal parts (subsystems or lower-management levels) and to the other systems (for example, the state educational system) of which it is a part. This must be done to determine how

*The relationship between management levels and information-support needs are discussed by J. H. Burrows in "Information System Overview" (see Preface).

**The author classifies "hard" sciences as those derived from the physical sciences, for example, mathematics, operations research, physics, etc. "Soft" sciences are equivalent to behavioral sciences such as psychology, sociology, anthropology, etc.

the core system supports, that is, what information and in what form it supplies to the other systems, and vice versa. An important part of this effort is the clarification and redefinition of key organizational goals and objectives as well as the identification of future trends that may affect the achievement or the importance of those goals and objectives. Future trends will help to determine which goals and objectives are important and, in turn, what information (form and context) may have to be exchanged in achieving them. These two steps lead to the development of the system-descriptive and predictive contexts shown in the Chart on page 8.

Step 5 attempts to translate the static view of the core system provided by Steps 3 and 4 into a more realistic representation of what it really is – a maze of interdependent but separable subsystems related by means of dynamic processes. This is achieved by adding such dimensions as time (when are inputs to budgetary planning needed?) and frequency and volume of information flow in support of key activities, such as budgetary

planning and evaluation, about which critical decisions must be made. The insights acquired or inferred from analyses of such dynamic processes permit the MIS Task Force to develop an action-oriented functional context that, by cutting across the organizational levels identified in Steps 2 and 3, provides a perspective on the organization in action. Its purpose is to represent the type of support provided to the decision-making process by various organizational units regardless of their levels within the organization.

The contexts provided by conducting Steps 3 through 5 permit an integrated context of the core system to be established (Step 6), a context critical to organizational problem-finding. In order to derive it, data collected from previous analysis efforts must be synthesized. Once established, the context provides another means of clarifying organizational problems, some of which may not be immediately amenable to computer aids.

At Step 7 substantive interaction between all members of the MIS Task Force becomes a dominant factor. The effectiveness of the dialogue established is tested as problems are translated into requirements and applications concepts. The contexts

developed, especially the functional and integrated contexts, allow the MIS Task Force to empirically assess the value of information support to various decision-related activities. Such understanding of value provides a basis for determining the importance of the various problems identified and, at a later stage (during design synthesis activities), permits the proper cost/value trade-offs to be made. The higher the priority assigned to a problem, the greater the attention given to the conception of an application. Application concepts, the final product of the requirements analysis, provide inputs to the design synthesis.

The last step involves recycling some of the data collected during the first seven steps through one or more of those steps in order to clarify the nature and causes of the more important problems so that, if necessary, additional MIS operational capabilities can be conceived and existing application concepts refined and restated.

The remainder of Part 1 of this paper provides details of the analysis effort associated with each step.

Organizational Requirements Analysis

Step 1 Determining Management's Viewpoint and Constraints

- Type and Extent of Cooperation
- View of Problems
- Time and Scope of Effort
- Long- and Short-Range Expectations

Organizational Requirements Analysis

Step 2 Identifying the Organizational System of Interest

- Organizational Level ("Core" System)
- Key Organizational Units
- Responsibilities
- Activities
- Problems
- Key Existing Information System Interfaces

The first two steps in organizational requirements analysis lay the foundation for the over-all effort. Both focus on bounding the scope: Step 1, that of the analysis effort and Step 2, that of the organizational system to be analyzed.

Step 1 represents an initial attempt to create a common dialogue among members of the MIS Task Force: that is, not only the steering committee but those managers and technical personnel who will be the most involved in MIS development. Discussions should be exploratory in nature, with the information-support design team probing the manager's viewpoints. Management's motivation for initiating the study,

its view of critical problems and of the time and money available to study them, its assessment of the political climate relative to the introduction of change,* and its advice on the feasibility and constraints of interfacing with other computer-based (or manual) systems are among the topics that should be discussed.

The context developed will provide a broad scope for the MIS development effort. In creating this initial dialogue management should be alert to the danger of miscommunicating impressions to technical personnel unfamiliar with the organizational setting and to reactions that indicate whether or not the outside consultants demonstrate a willingness to suppress their own biases regarding problems and solutions.**

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*For a manager's viewpoint of how change, especially introduction of a formal information system, affects organizations, the reader is referred to J. H. Burrows, "Persistent Problems in System Development" (see Preface).

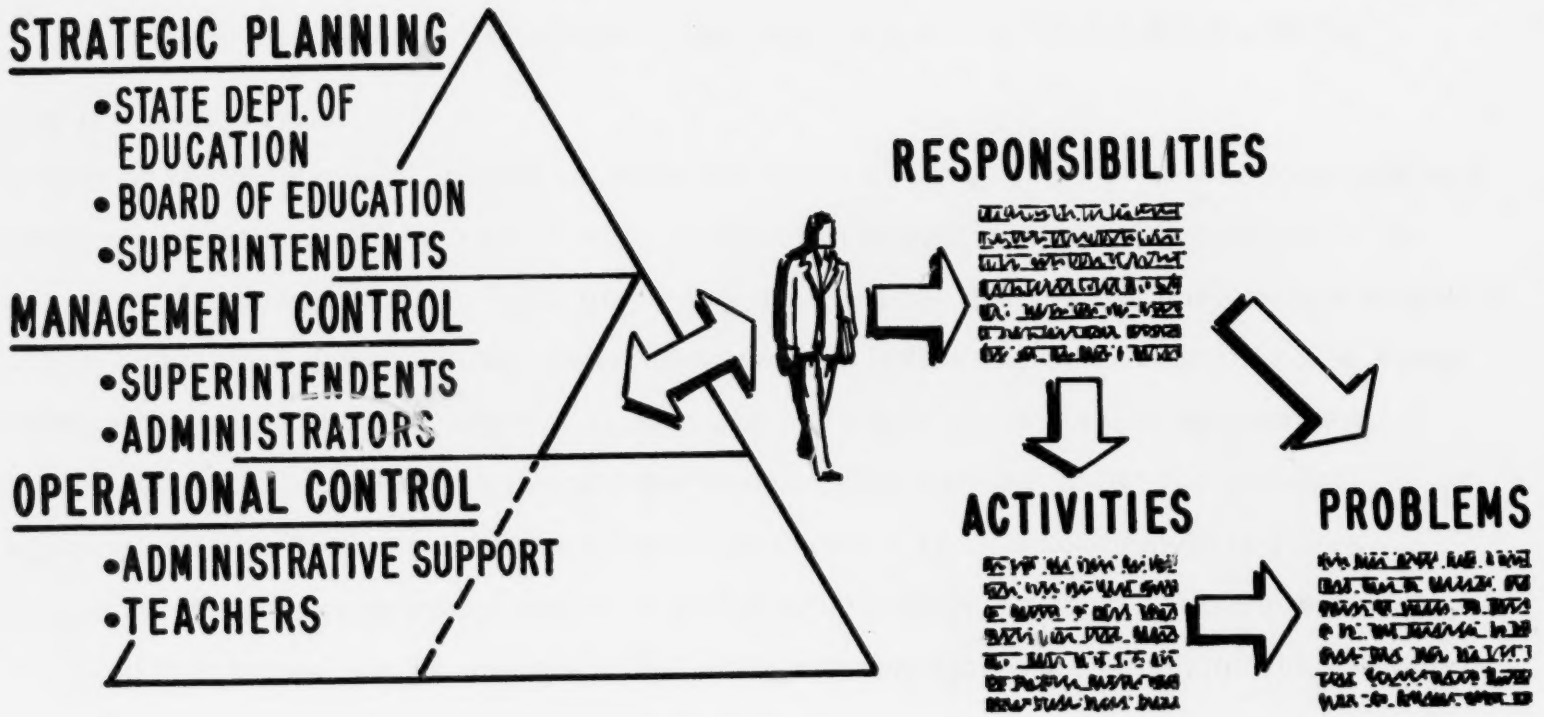
**This point also is covered by J. H. Burrows, op. cit.

Step 2 is structured to dispel a myth commonly associated with applying the systems approach: that of assuming the entire system, including the external systems with which it interacts, must be studied to an equal extent. The approach used in Step 2 is to select a management level within the organization – in this case, the district superintendent level – and define it as the core system or focal point of the analysis effort. The other organizational units (internal) and major systems (external) with which core system interacts can be identified (see Chart on page 25). Major information exchange areas can be determined and serve as a means of providing some initial insights on the degree of interdependency among the units and other systems that are a part of or interact with the core system.

In developing a systems perspective, the MIS Task Force should guard against delving too deeply into describing <u>all</u> the responsibilities and activities of a particular

EXECUTIVE INFORMATION SYSTEMS	A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT

WHERE TO START



organizational unit; rather, its focus should be on the most important responsibilities and activities of the superintendent and his staff, noting now how these differ from or relate to one another in order to determine, at least by inference, the likely management and information problems. Any existing information systems, whether external or internal and especially those that are computer-based, with which the core system does or may in the future interact should be identified for later study.*

The next several charts and associated text will elaborate on the development of a system perspective.

*Awareness of the existence of other developing information systems which may have to be able to compatibly exchange data at some time with that of the core system is very important to the analysis and design effort. A persistent problem related to information system integration is the standardization versus adaptability trade-off which is discussed by J. H. Burrows in "Persistent Problems in System Development" (see Preface).

. . . The company . . . may feel that it has taken a systems approach to its problems if it has asked a computer company to examine its information system and determine how the computer can be used . . . Computers are undoubtedly a system . . . But even though the computer department is well-designed from a systems viewpoint, this does not mean that its activities in the company constitute a systems approach to the company's problems.

C. West Churchman,
Systems Approach;
Delacorte Press, N. Y., 1968

Organizational Requirements Analysis

Step 3 – Acquiring a Systems Perspective of the Organization

Establish

System-Descriptive Context

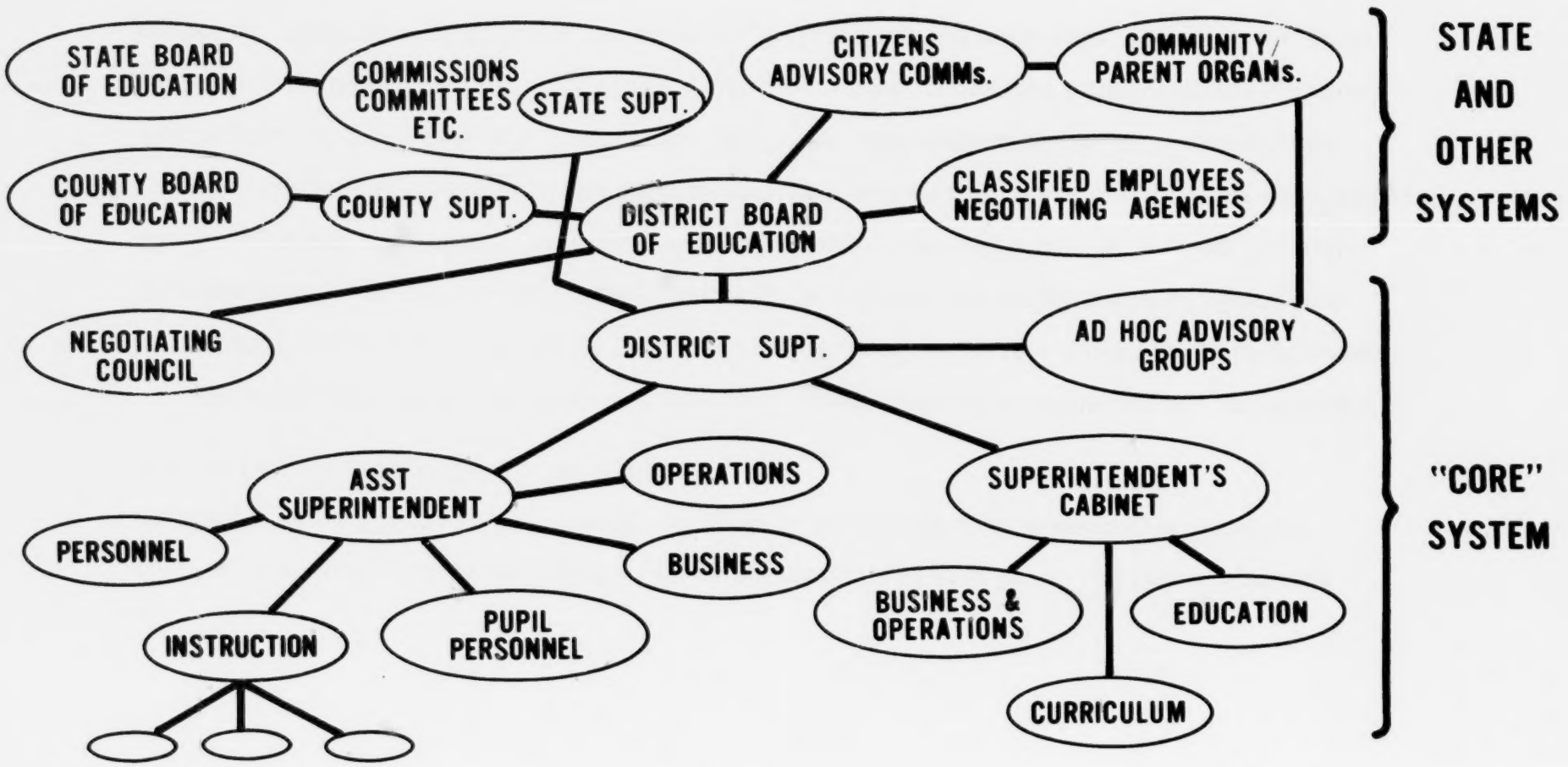
- **Function-Responsibility-Activity Alignments**
- **Major Decisions and Products**
- **Relation to External Systems**

Predictive Context

- **Trends and Issues Analyses**

A common fallacy, often made, is to implement MIS operational capabilities without first re-examining fundamental management objectives and the structure and the operational environment of the organization. The resulting information-support system requirements are vague or irrelevant, frequently leading to unnecessary and costly computer aids. The setting of objectives and determination of organizational structure, in turn, depend upon the understanding of the operational environment of the organizational system, both now and in the future. The operational environment —— in this paper, that part of the world external to the district superintendent's level (see core system in opposite Chart) —— consists of those organizations or groups, formal and informal, with which the

OPERATIONAL ENVIRONMENT OF THE "CORE" SYSTEM



core system interacts and to which it must be responsive (see State and Other Systems (in the previous Chart). It is exactly because of the complexity of such relationships that a systems perspective is necessary.

Once the operational environment has been characterized to some extent, an analysis of the internal core system can be initiated. When conducting this analysis, it is important to move across organizational boundaries, that is, across the organizational chart (see Chart opposite), in order to obtain an understanding of the collective as well as the individual decision-making role of each organizational unit as it carries out its responsibilities. Key organizational elements, resources, facilities, and activities can be isolated* and insights established as to form and types of information exchanged between organizational systems. This type of analysis, in essence, relates the parts or subsystems to the whole or core system.

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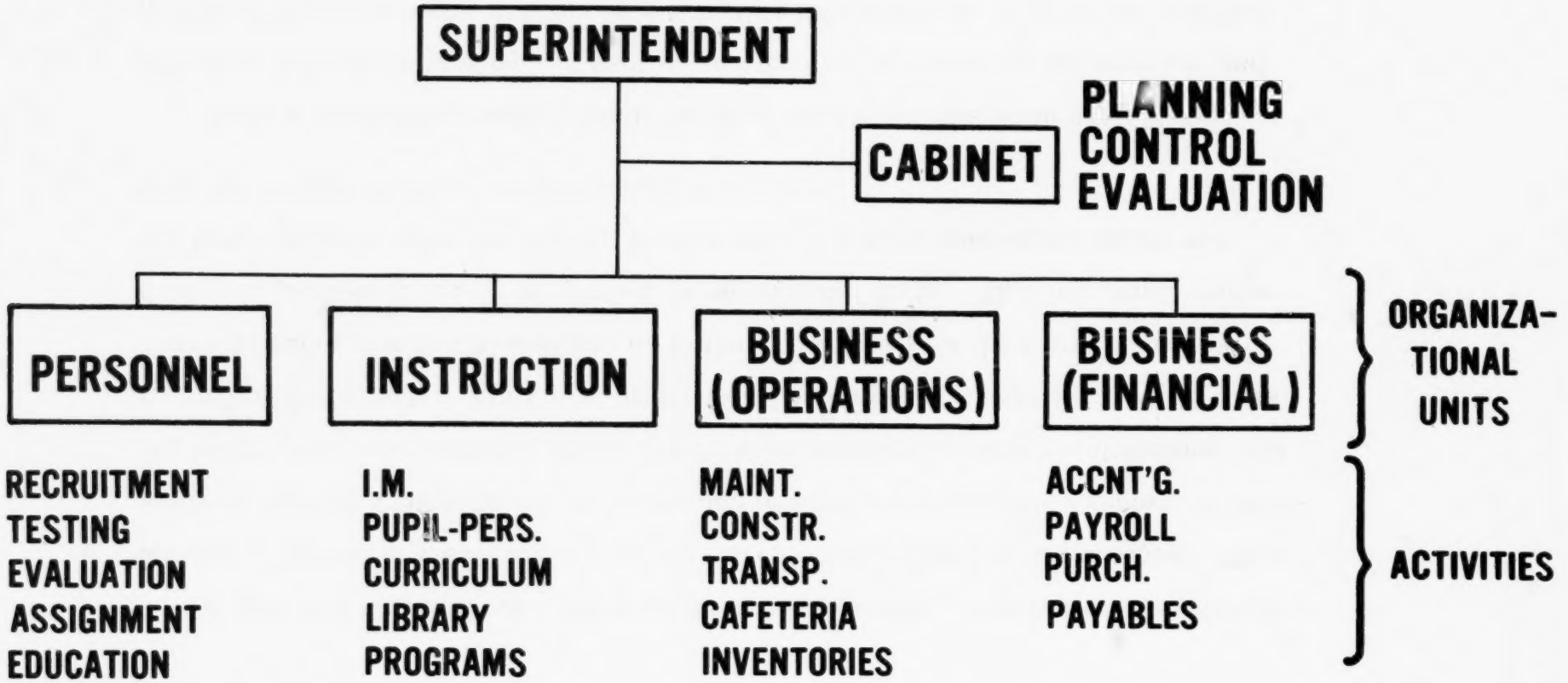
*Because of its importance, mission analysis, which is essential to establishing the system-descriptive context, is discussed separately in Step 4.

EXECUTIVE INFORMATION SYSTEMS	A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT

OPERATIONAL ENVIRONMENT OF THE "CORE" SYSTEM



In this way a system-descriptive context is acquired. Function-responsibility-activity alignments are identified, characterized and related to one another. This analysis also identifies major decisions and products (for example, reports containing budget recommendations) whose information-support system requirements will be analyzed in greater detail at a later date. In so doing, it permits the MIS Task Force to gain some initial insights as to the multiple use of the same data – for example, personnel data – by various organizational units. This has implications for later recommendations leading to cost-effective data base organization and over-all design of the information-support system.

Next, a predictive context should be developed by means of an examination of trends and issues that may impact on and thus be important to the survival and growth of the core organization. In conducting this analysis, a broad-to-detailed comprehension of trends, issues and needs is sought, giving particular attention to key indicators: major developments, undergoing substantive change at accelerated

rates, which will have a significant impact on the core organization's future operational effectiveness. The primary reason for developing this predictive context is to more sharply guide the analysis toward problems of growing importance and toward increasingly important responsibilities and activities and to avoid overconcentration on activities which may become less important in the future.

After a first-pass at characterizing the external and internal system environment and thinking through the impact of future trends and issues on the core organizational system, a more balanced systems perspective can be acquired through synthesis of the data collected, thus allowing the MIS Task Force to move from a superficial understanding of management problem symptoms (see Step 1) to more substantive understanding of real problems facing the core organization.

Organizational Requirements Analysis

Step 4 – Performing the Mission Analysis

- Conduct Top-Down Analysis
- Conduct Bottom-Up Analysis
- Establish Interrelationships Among Key Objectives
  - Priorities
  - Hierarchies
- Derive Effectiveness Criteria
- Synthesize Goals and Objectives

Although an essential ingredient in establishing the system-descriptive context, mission analysis, which results in clarification of organizational goals and objectives, should be initiated after some understanding of the core system's present and future operational environment has been acquired. Effective formal information systems are designed only in response to clearly defined goals and objectives. A natural tendency in analyzing organizational systems is to attempt this step first. Though preferable when analyzing some types of systems – for example, space systems,

where the goals and objectives are few in number, easily identified and not so interwoven with changes in the environment – complex social-economic systems must be much more systematically understood prior to undertaking the clarification of goals and objectives.

Goals are broad future-directed statements, usually resulting from political negotiations, which focus issues and reflect major interests. They express more tangibly than a statement of organizational mission the general directions, priorities and contraints related to the achievement of programs. Once adopted, they become the basis for formulating more specific near-future statements (objectives) toward which specific programs are aimed. Objectives more precisely specify what outcome is to be achieved and when. Activities are sets of tasks which must be performed by identifiable organizational units in order to achieve objectives.

The above underlined terms are hierarchically arranged to show their relationship to mission. Understanding this relationship provides a means for educational

managers to more clearly perceive how their jobs, regardless of level, contribute to carrying out the organizational mission. Translating goals into activities (sets of tasks) identifies information needs and provides the information support-design team with a basis for identifying specific MIS capabilities. By conducting a mission analysis, the MIS Task Force can move a step closer to a common understanding of complex concepts.

Two approaches are applied to determine what the direction (mission) of the core organization should be. First, a "top-down" analysis is used to derive challenging and relevant goals and objectives. These are tempered by the realistically achievable goals and objectives derived from observation of actual organizational activities via a "bottom-up" analysis. A synthesis of the insights derived from these two analyses provides the refined basis for more comprehensive and clear-cut statement of goals and objectives.

The essence of top-down analysis is the translation of projections about the core system's future operational environment (predictive context) first into a set of broad, long-range hierarchical goals and then into some specific objectives directed at short-run achievements that can be accomplished with available resources. The bottom-up analysis primarily draws on the system-descriptive context and involves clarification of how resources — personnel, financial and physical — actually are allocated and why. This leads to a more refined understanding of management problems and constraints. A synthesis of goals and objectives leads to an ability to identify those that are realistically achievable, to determine which are most important and thus to clarify existing statements of mission.

A major pitfall in setting objectives is to try to conceive a comprehensive and exhaustive listing, hierarchically arranged or otherwise. The list can easily become unmanageable and defeat the whole purpose of deriving objectives because the more important ones can no longer be quickly and easily identified. Thus planning

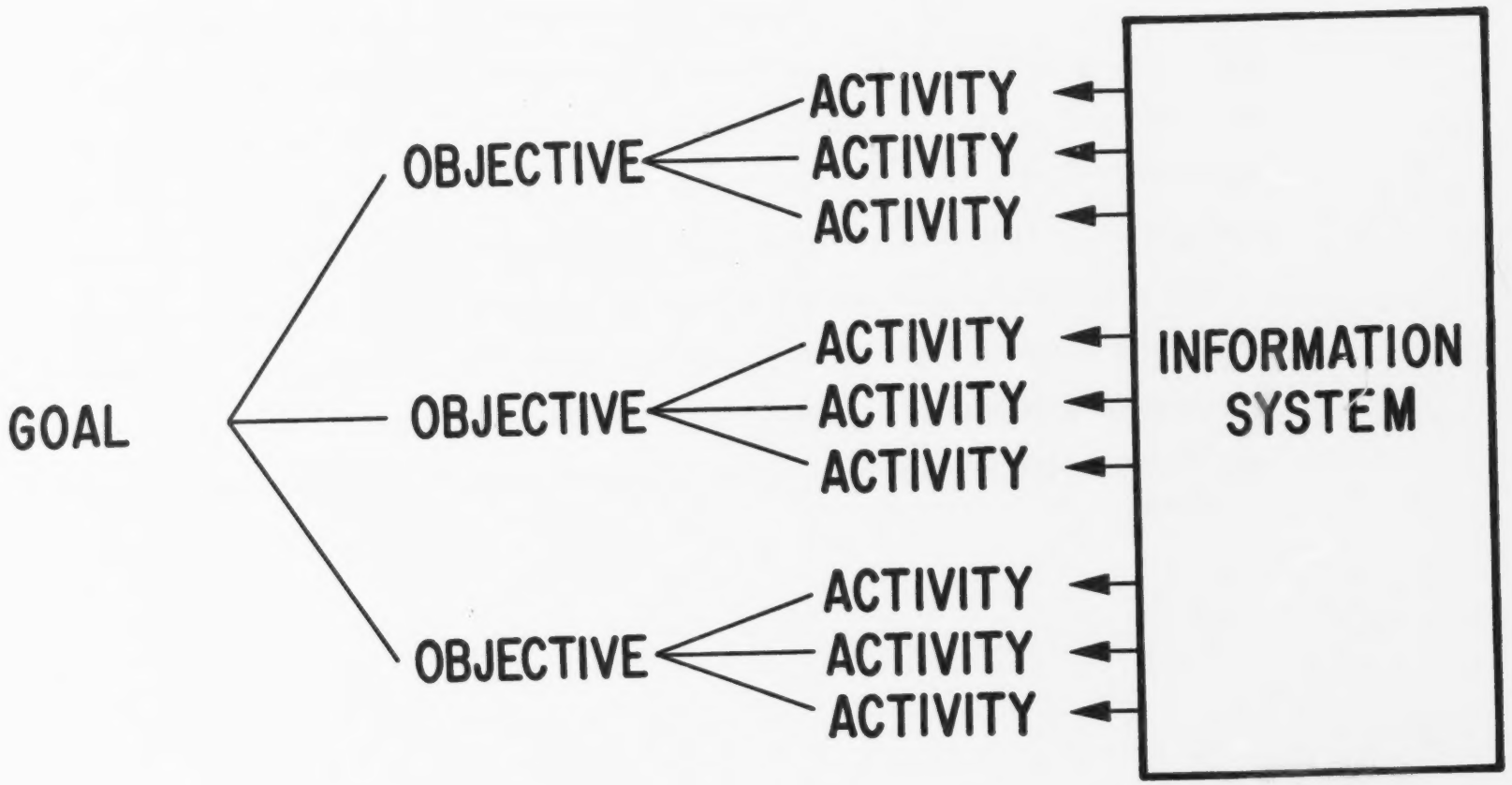
and resource allocation become unnecessarily complicated, to say nothing of the information system reporting problems that would ensue if various managers tried to achieve simultaneously the accomplishment of objectives which may be unrelated and of lesser importance than others.

To counteract this tendency the insights derived from the systems perspective are used to assign priorities, delete, simplify, combine and otherwise surface key objectives and restate them. A counterpart to this effort is the establishment of qualitative as well as quantitative criteria by which management can determine organizational and program effectiveness: that is, achievement of goals and objectives. Literal translation of the systems approach and its "cookbook" introduction to the educational management development programs has placed too much emphasis on the quantification of objectives, that is, on using only those objectives with quantifiable factors and variables. Better statements of the more important objectives, some of which may not be quantifiable, and

development of both qualitative and quantitative indicators of achievement has been neglected. Forcing managers to focus on easily quantifiable objectives often has led to the selection of the wrong objectives. In education such practice, if continued, will demoralize especially lower-level management (for example, teachers) and contribute to organizational disruption. This will lead to polarization of viewpoints and make more "rational" management practices and aids difficult to implement. Longer-range organizational effectiveness and more relevant educational services will be sacrificed in order to demonstrate short-range but irrelevant program efficiencies.

EXECUTIVE INFORMATION SYSTEMS	A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT

GOALS – OBJECTIVES – ACTIVITIES



The above chart shows the sensitivity of cost/effective information-support system design to the clarity with which goals are defined. The more clearly broad goals are relatable to specific activities, the easier it becomes for the MIS Task Force to identify the nature and value of the information that will be required by organizational units in carrying them out. (At a later stage, the nature and value of the information required will be traded off against the cost of incorporating MIS capabilities to provide this information.) To the extent that the relationships between goals and activities are not understood or are conflicting or vaguely defined, the information-support system design team will be unable to determine relevant MIS options, often leading to excessively expensive and inappropriate systems.

In theory, the relation of goals to objectives to activities appears to be a straightforward task. In the real world quite the opposite is true, particularly in educational systems, where the goals and objectives are multiple, ill-defined and unagreed upon, where the public-policy decision-making process involves numerous organizational

EXECUTIVE INFORMATION SYSTEMS	A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT

THE MIS TASK FORCE DILEMMA

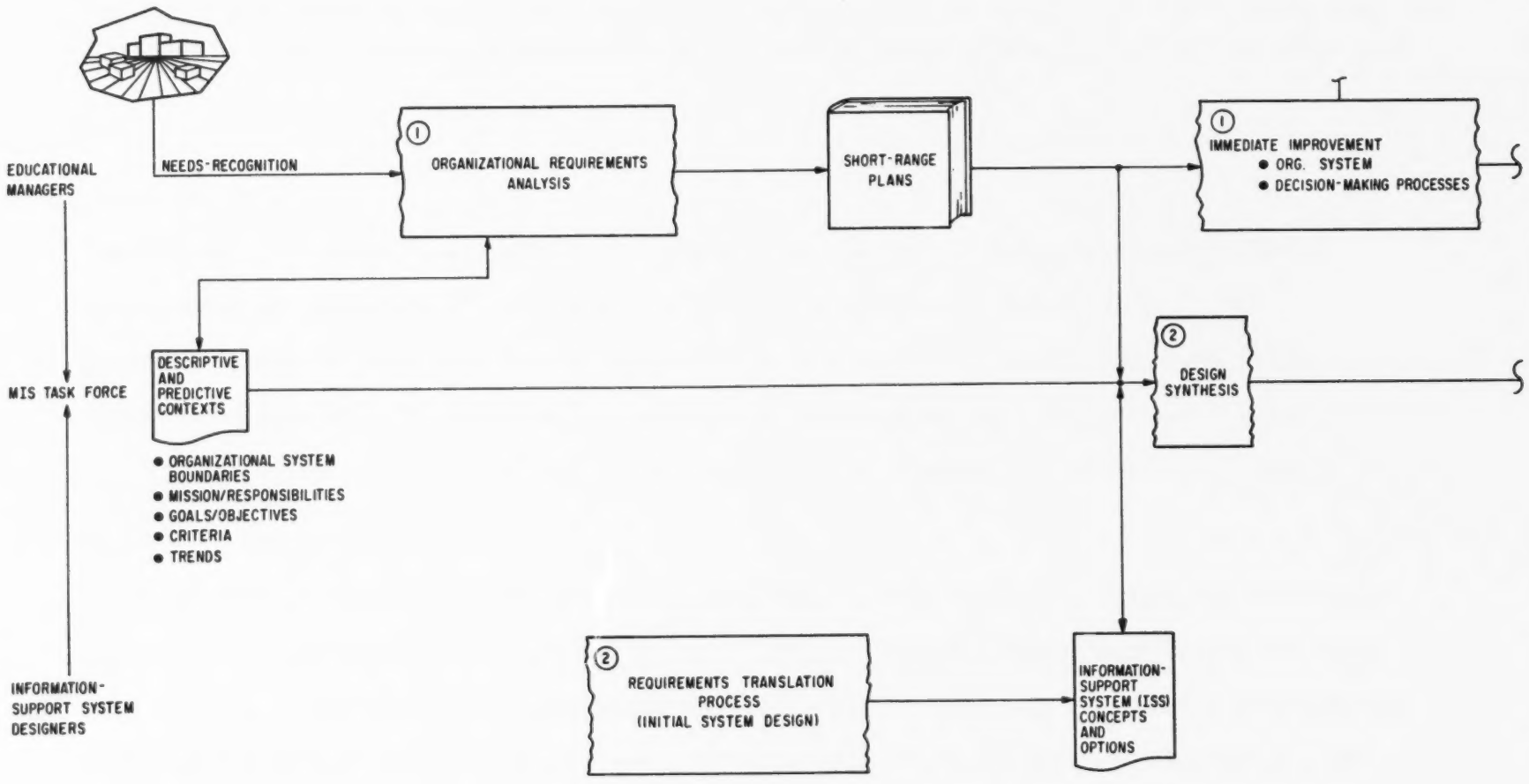
REAL-WORLD GOALS (ORGANIZATIONAL & INDIVIDUAL)		GOALS FOR DESIGN GUIDANCE
MULTIPLE COMPLEX UNDEFINED CONTROVERSIAL	?	SIMPLE CLEARLY RELATED PRECISELY DEFINED NON-CONTROVERSIAL

entities and where, in contrast to industrial outputs, improvements to the products – the value added to the raw materials (students) – is extremely difficult to measure and evaluate. This is quite disconcerting to the information support-system design team who would like simple, clearly related, precisely defined and agreed upon goals and objectives as a basis for stable design guidance.

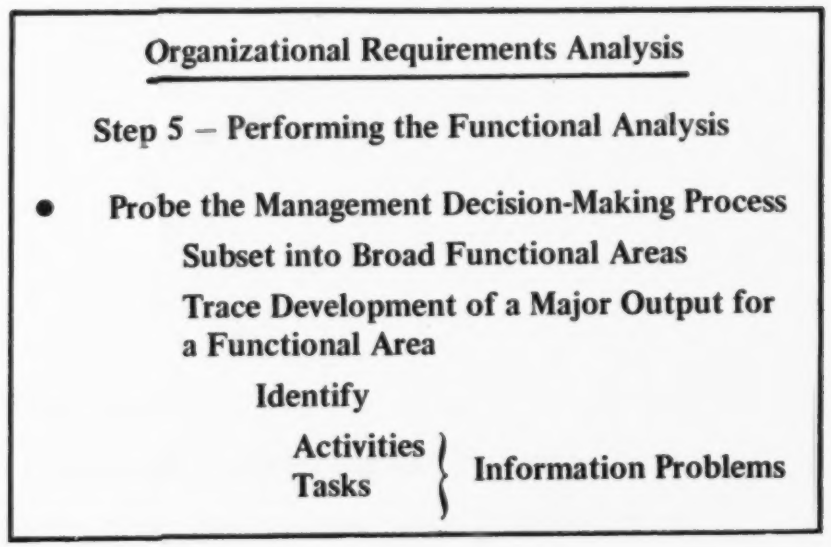
The dilemma faced by the MIS Task Force is to do a better job of assisting educational managers to think through goal statements to the point where less risky, more adequate design options can be formulated. The job of better educational goals definition cannot be delegated by educational managers or the result will be highly oversimplified, irrelevant goals with overemphasis on identifying easily measurable goals and objectives.*

*A case in point is recent educational experience with PPBS where the job of goal definition was left, to a great extent, to the information-support system designers. One result has been that information to support planning decisions is of little value because clear statements of realistic goals were not reflected in the design concepts.

EXECUTIVE INFORMATION SYSTEMS | A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT



As previously indicated, a systems perspective is critical to analyzing the complex and dynamic processes that reflect the organization in action. By selecting a core system, we made the analysis effort manageable. We then were able to concentrate on identifying critical relationships: those of the core system to the external systems with which it interacts as well as those of its subsystems to each other and to the organizational mission; the relationship of the core system to its current operational environment and projections of how that environment, and consequently the relationships, may change; the relationships of organizational mission to goals, objectives, activities and tasks, and the contribution of each to organizational effectiveness and efficiency; and, most important, an initial understanding of the relationship between the organization's information system to its mission. In effect, we began to subset complexity and in so doing derived system-descriptive and predictive contexts which, albeit static, are understandable by and useful to all members of the MIS Task Force.


Organizational Requirements Analysis
Step 5 – Performing the Functional Analysis
• Probe the Management Decision-Making Process
Subset into Broad Functional Areas
Trace Development of a Major Output for a Functional Area
Identify
Activities
Tasks
Information Problems

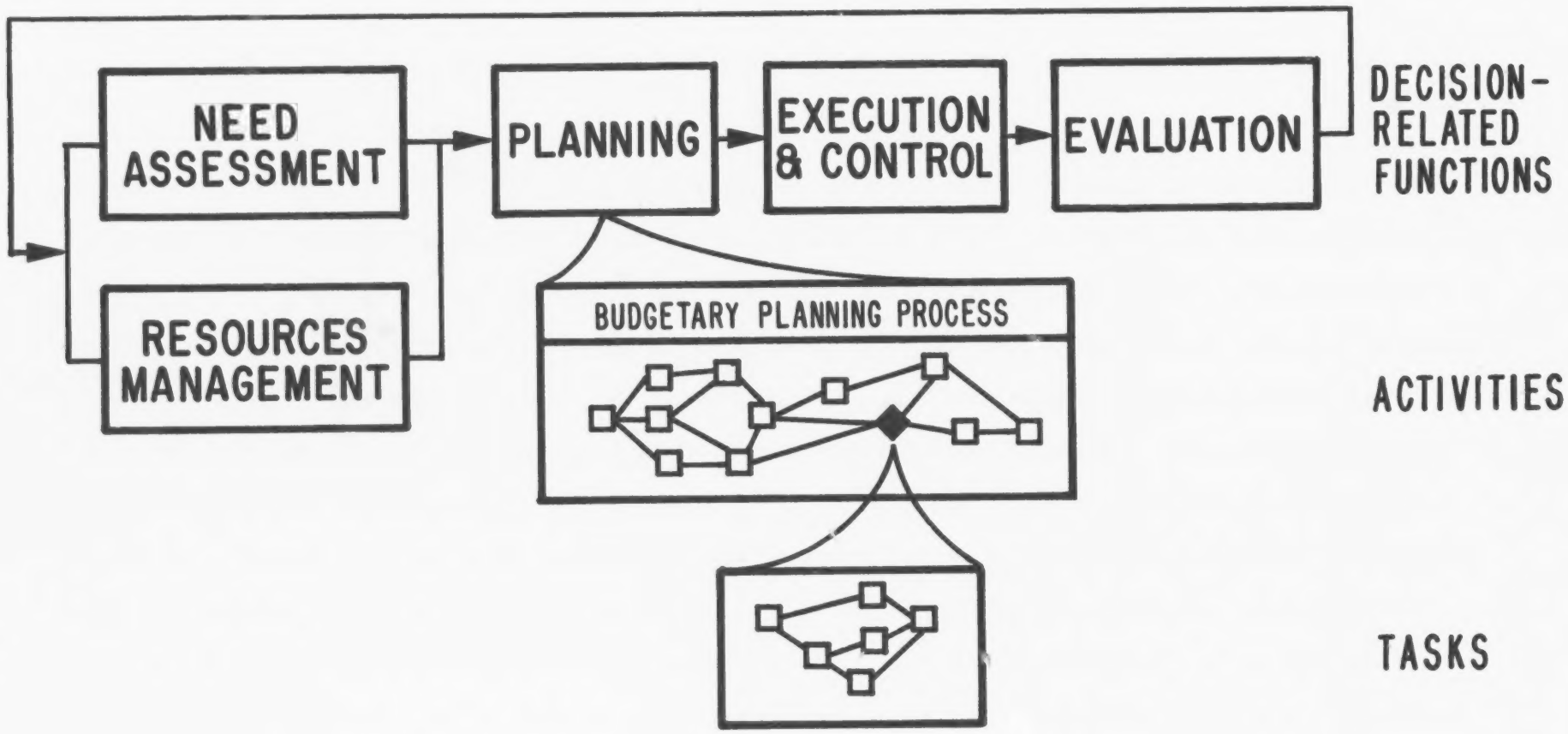
The contexts developed, however, are not an end in themselves but rather the building blocks for conducting the functional analysis, an effort that further subsets complexity by cutting across organizational levels in order to align tasks and activities with decision-related functions. A description of the core organization limited to rules, procedures and mission, no matter how accurate, is inapplicable to identifying information-support system requirements without an analysis of the major management functions that convert information into action and which thus can be supported by MIS capabilities. Conversely, a major pitfall in conducting functional analysis is to proceed without having a basic context that characterizes the core system in terms of its relationships. The result in such cases is the indiscriminate tracing of too many types of activity and information flows in too much detail coupled with an inability to determine the impact of individual information problems on the achievement of organizational objectives.

Functional analysis then is used as the mechanism for probing the management decision-making process, thereby adding a dynamic aspect to the static view of the core system. In conducting it, a model of the decision-making process in terms of five major management functions (see Chart on next page) replaces the traditional organizational chart. This model, grossly simplified, introduces the concept of flow and shows that decision-making is an iterative process carried out over time. Thus decisions made in one functional area impact on other functional areas. The most important reason for using this model, however, is that it shows the Task Force that activities and tasks carried out within individual units, regardless of their organizational levels, do support the decision-making process, and hence the organizational mission. This understanding of the organization in action allows the MIS Task Force to study a specific function such as budgetary or program planning in terms of the specific activities, tasks and information that support it to the level of detail necessary for the identification of information-related problems.

In tracing the flow of information through the organization, additional insights for conceiving MIS capabilities can be acquired. Consider, for example, a critical aspect of information, its timeliness. Clearer insights of when the information is needed and of the activity that needs the information —— is it rhythmic in nature, such as budgetary planning, or is it more "one-time" in nature, such as strategic planning —— can be acquired. Other insights gained relate to the volume, frequency and usage of data: What data at what level of detail are required by which organizational units from, say, the personnel files? How often is it updated and retrieved? How is it used by the activity or task in supporting specific management functions?

EXECUTIVE INFORMATION SYSTEMS	A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT

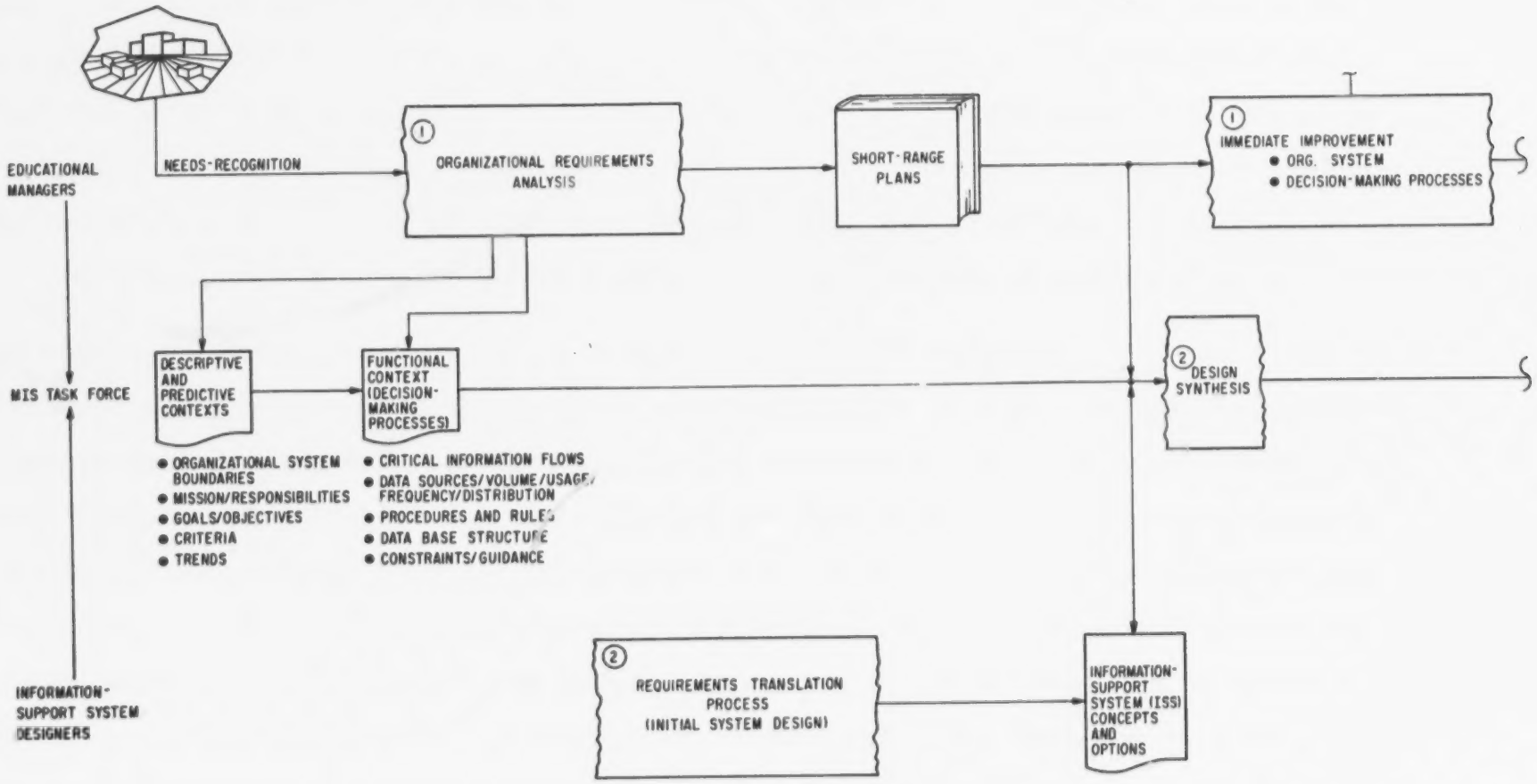
FUNCTIONAL ANALYSIS



Blending such insights with those gained in establishing the system-descriptive and predictive contexts adds another dimension to question of value, that is, the value of having specific information available at a specific time. Understanding the sensitivity of the relationships identified earlier is extremely important in this respect. The impact of, for example, late or inaccurate cost/benefit information on some programs at various grade levels within a school district can be realistically assessed only if the relationships of such programs to goals and objectives have been clarified (see page 31). Questions regarding the completeness, accuracy and relevance of data also must be addressed and initial assessments made of the existing information-support system, whether manual or computer-based. These are but some of the considerations that must be weighed in establishing priorities for alleviating information problems.

One last point to be made in regard to functional analysis is that, in conducting it, the Task Force will not only be asking questions of What, Where and How, but at some point, questions of Why: Why is the budget prepared in this way? The answers to questions such as these will show that some of the apparent information related problems in reality are problems associated with the decision-making process (or the organizational structure) and, as such, should be resolved before information requirements are set in concrete. Aggregation and reclassification of the various types of problems which have been brought to light by the functional analysis requires another view of the organization, that provided by an integrated systems context.

EXECUTIVE INFORMATION SYSTEMS | A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT



Organizational Requirements Analysis

Step 6 - Developing an Integrated Systems Context

- **Reduce Possible Conflicts in Data**
- **Restate and Aggregate Problems**
- **Assess Core System Efficiency and Effectiveness**
- **Reclassify Problems According to**
  - **Need for Information-Support Capabilities Only**
  - **Decision-Making Process**
  - **Organizational Structure**
- **Assign Responsibility for Problem Solution**

Having established contexts that describe basic relationships (system-descriptive and predictive contexts) and one that provides a more detailed view of the organization in action (functional), the MIS Task Force, and especially those educational managers involved with it, has acquired two different and isolated views of the core system. The purpose of structuring analysis efforts so that such contexts could be established is to provide the data, insights and concepts that can be synthesized and used to derive a balanced and integrated perspective.

This perspective is critical not only to MIS evolutionary development but, most important, to middle management itself.* Because of its role in the organization, managers at this level must understand the total organization** in order to carry out their responsibilities.

Achievement of an integrated and balanced perspective requires that data used to acquire it should be reconcilable, at least at some level of aggregation. This means that data collected during organizational requirements analysis at different times and for different reasons — for example, to identify relationships, to describe the current and projected operational environments and to subset complexity — by different groups and from different sources must be recombined. This effort

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*As stated earlier, the district superindendent's level is defined in this paper as both the middle management level and the core system of interest.

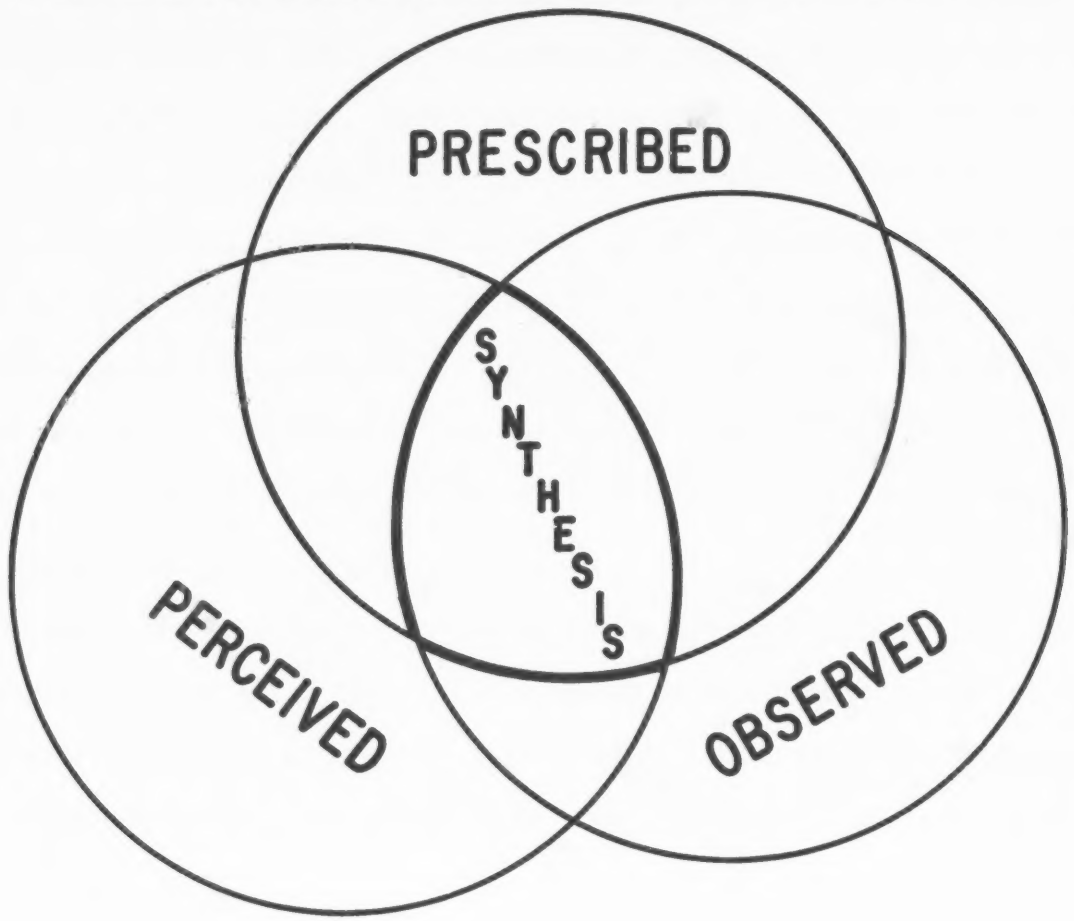
**For a discussion of management levels and roles in organizations, see Robert N. Anthony, Planning and Control Systems: A Framework for Analysis; Boston, Harvard University Press, 1965.

provides data that contain conflicts, apparent or real, which must be reconciled before an integrated systems context is established. The conflicts stem from the fact that the inputs represent three different views of the core system — as prescribed, as perceived and as observed — and that each view differs. To understand why this happens requires a brief discussion of the three types of viewpoint.

Data acquired on how the system should be operating (as prescribed) are acquired from formal statements of policy, procedures and directives. Data collected from interviews with key personnel reveals how they think the system is operating (as perceived). The way they carry out their tasks and responsibilities reveals their interpretation of the goals and objectives contained in the formal statements. People in a system act toward each other and toward information and computers in accordance with the way they see things, not in accordance with the books or facts. Data collected on how the system appears to be operating (as observed) are acquired from the interviewer's notes or from observations informally expressed. Thus it can be seen that when the data are finally amassed, conflicts are embedded in them.

EXECUTIVE INFORMATION SYSTEMS	A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT

TYPES OF DATA SYNTHESIZED TO ESTABLISH INTEGRATED CONTEXT



Reconciliation of these data, a major task, is a prelude to their aggregation and to the establishment of an integrated systems context, necessary ingredients for more clearly stated problems. In reconciling (synthesizing) them, indicators of gaps and inconsistencies will surface, pointing out the need for selective iteration of some aspects of the requirements analysis process, possibly with the aid of more sophisticated techniques (see Step 8). The synthesized and refined data provide a more realistic basis for understanding the core system operations. Problems can be more rationally sorted out, compared for differences and similarities, much more explicitly restated, and the data further aggregated as a next step in identifying information requirements at a higher level of generality, that is, functional and organizational requirements and constraints.

This reconciliation and aggregation process is aided by asking several basic questions about the effectiveness and efficiency of the core system. For example, given the present decision-making process, organizational structure and mission, can costs be reduced by

eliminating redundant acquisition, processing and use of data (efficiency orientation)? Given the present decision-making process and organizational structure, can the resources be used differently to achieve more relevant objectives and goals (effectiveness orientation)? An even more fundamental effectiveness-oriented question can be asked: namely, from an understanding of the core system's current operations and of its growing educational needs, what is a more challenging set of realistic goals and objectives, and what changes are necessary in information support, the decision-making process and the organizational structure to achieve such goals and objectives?

The integrated systems context also assists the MIS Task Force in more sharply distinguishing among the types of problems embedded in the core system as (1) those that cannot be solved by MIS capabilities at all, (2) those that can be directly alleviated by MIS capabilities without first addressing problems of organizational structure or the decision-making process, and (3) those that are tightly interrelated with the decision-making process and/or organizational structure and require collective and highly coordinated managerial efforts for their resolution. Such problems must be solved before useful information requirements can be identified.

Examples of problems in (1) are lack of finances, lack of the right skill mix to carry out the organization's goals and objectives, and poor or confused objectives and goals. Problems directly resolvable by MIS capabilities, category (2), are those associated with tasks or activities such as payroll processing. Changes in organizational structure or in the decision-making process may produce changes in names, salaries and deductions on the payroll, but the latter types are anticipatable and can be accommodated by including update procedures in the basic design of the payroll application package.

Alleviation of problems in (3) is the most complex from an implementation point of view because unanticipatable redistribution of status and power is at stake, creating new and more subtle problems. Unless problems in (3) are resolved, the organization's MIS capabilities may be providing support to a misinformation system.

Apparent information-related problems such as conflicting reports generated by different sources, lack of periodic comparative data, and multiple preparation and distribution of identical data may, upon closer examination, turn out to be symptoms of problems in organizational structure — a lopsided management-support structure,

distribution of similar functions or responsibilities over too many organizational units, the existence of administrative positions with no-clear-cut responsibilities or duties, lack of communications among management personnel, lack of a proper span of control — or of the decision-making process — overcentralized decision-making, undue emphasis on "going through channels," the existence of a line-item budgeting procedure that minimizes the ability to manage and that does not relate resources to specific educational programs, the lack of a procedure for establishing priorities, and so forth.

Resolution of such problems requires clarification of organizational goals and objectives and of responsibilities, areas that only educational management is qualified to address.

Organizational Requirements Analysis

Step 7 – Translating Information-Related Problems Into Requirements

- **Concentrate First on Selected Short-Range Problems**
- **Frame Requirements for Longer-Range Problems in Less Detail**
- **Document Requirements and Constraints**
- **Assess Value of Alleviating Problems**

The above step is perhaps the most critical to the success of the design effort. It involves the shake down and separation of information-related problems into two categories: those which can be immediately addressed and those which should be deferred until initial operational capabilities have been implemented. Several criteria that assist in determining which problems belong to the first category are presented in the form of questions on the following page.

(1) What is the value of alleviating the problem to the decision-making process and to organizational objectives?

(2) Is the problem associated with a task or activity that has relatively few variables and well-defined cause-and-effect relationships? *

(3) Is the MIS capability amenable to alleviating the problem available from off-the-shelf technology?

(4) Will its introduction into the organization cause relatively little disruption to the existing core system?

(5) Is the task, activity or function to be supported by MIS capabilities relatively insensitive to changes in organizational structure or in the decision-making process?

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*An activity such as payroll processing meets the criteria in (2) because its procedures are routinizable and hence relatively structurable — that is, the variables are relatively few and the cause and effect relationships easily identifiable. It also involves a low degree of futurity, causes minimal disruption to the organization, includes few qualitative factors, and is less unique (more repetitive) and more frequent in occurrence. Since the computer system relies on well-structured procedures for processing data, it is just good common sense to aid such easy-to-structure activities first. Moreover, the required MIS capability is relatively easy and inexpensive to implement because payroll application (software) packages are available from off-the-shelf technology. Most important perhaps is the fact that the advantages of computer-aiding this activity to alleviate its information-related problems are quickly visible to a broad spectrum of management.

(6) Will the capability implemented have widespread and positive political visibility?

(7) Is it relatively inexpensive and technically easy to implement?

Substantive interaction is required between the educational managers and the information-support system designers at this point. And it is here that the value of the manager's prior participation in organizational requirements analysis should crystallize. By participating, he sharpened his own judgment and insights and acquired a more balanced perspective. Such skill augmentation provides him with a more rational basis for answering questions (1), (4), (5) and (6), answers requiring the insights and expertise that only the educational manager has. While participation will not endow him with the technical expertise required to answer questions (3) and (7), his perspective on value will have been enhanced, providing him with a sounder basis for assessing the recommendations made. And he will know why payroll processing represents an activity that is easy to computer-aid and therefore meets the criteria of (2).

Consider now what happens if he chooses not to participate — if, instead, he delegates to outside experts the entire responsibility for analyzing his organization's requirements and designing its MIS. Even if he does not accept all the recommendations as made, he will

have no context other than intuition for accepting any of them. Some of those that he does accept may introduce unintended and disruptive change into his organization —— a pitfall that can be costly to the budget and disastrous to morale.

Once activities and tasks amenable to immediate computer-aiding have been selected, detailed documentation of requirements and application concepts must be prepared. Data handling and analysis procedures, for example, can be expressed in flowchart form. Detailed statements regarding information requirements, that is, the form and content of information products (that is, tables, reports and so forth), as well as identification of constraints such as the availability of data needed also must be prepared.

Proper statements of requirements should focus on what information products are needed and sketch, if possible, the type of decision-making process and man/machine procedures involved. A balance must be struck between too much vagueness (I want to plan faster), which is insufficiently informative to the design team, and too much specificity (I want a 3-second response time to all information requests), which may bias the design toward specific hardware equipment and software approaches.

One last point to be considered in identifying requirements is that a properly designed information-support system reflects a balance between the cost of technological aids and the value of alleviating information problems. Generally, however, the educational manager and the information-support system designer do not understand each other's job sufficiently well for either party to strike a suitable balance on his own. For example, if the manager asks for a maximum response time of 5 seconds, he should at least be made aware of the fact that if he relaxes this requirement and accepts a response time of, say, 12 seconds, he can save as much as $10,000 a year. Although he may not understand the technical design approach being used, he at least has a basis for trading off the value of the information (in this case the value added by receiving data faster) against the cost of supplying it in the time required. An essential part of any successful system design effort is therefore a constant and increasingly effective dialogue between the manager-users and the design specialists. The major thrust of the problem-finding process discussed in this paper has been to provide the common contexts which must be developed in order to create such effective dialogue.

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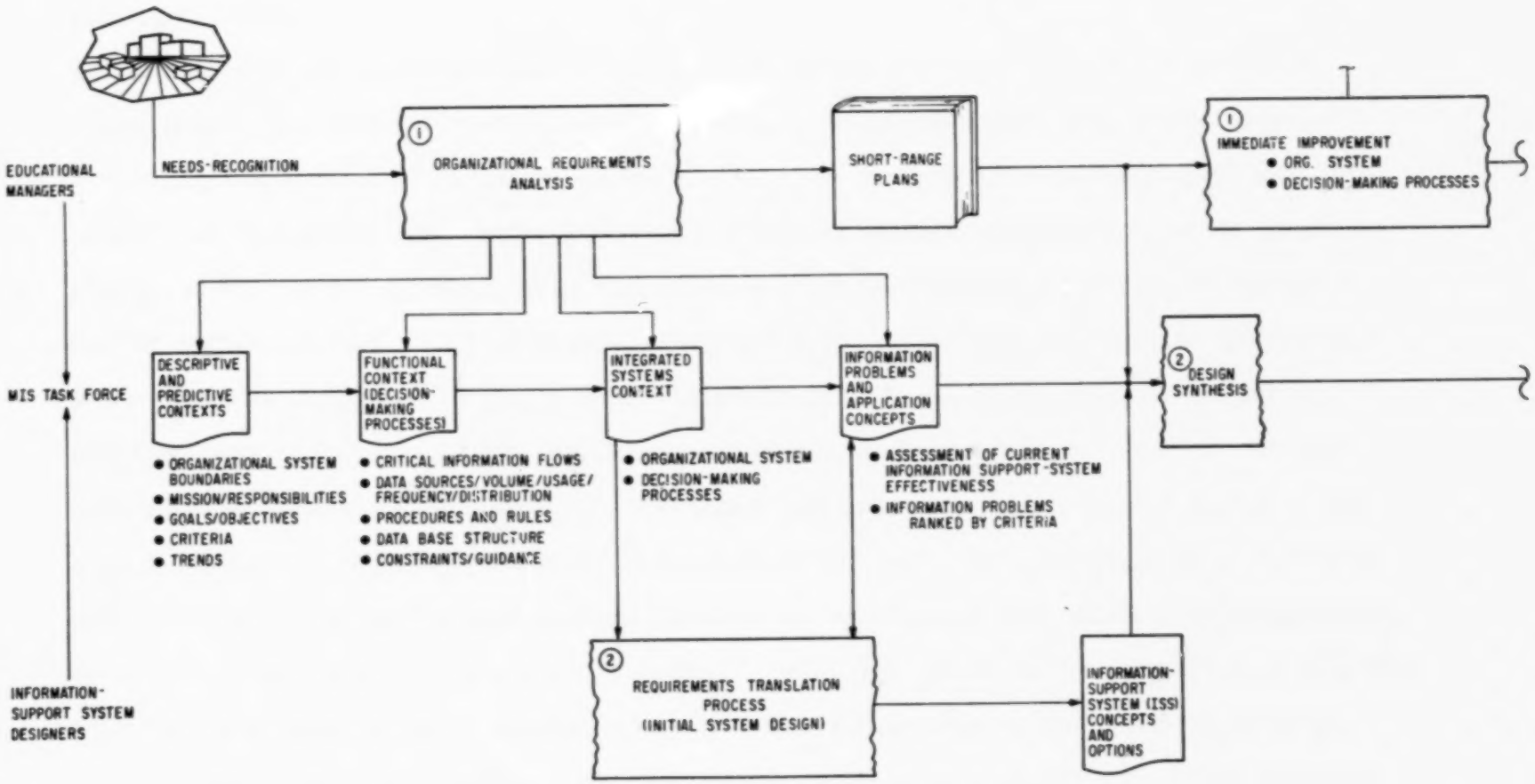
EXECUTIVE INFORMATION SYSTEMS

A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT



Organizational Requirements Analysis

Step 8 – Recycling To Validate Requirements

- **Validate Integrated Systems Context**
- **Consider Time and Funds Available in Selecting Inputs for Recycling**
- **Apply Appropriate Analysis Technique**
- **Compare New and Original Data**

Although recycling appears as a separate step and is shown in the conceptual framework as being implemented at only two points during the analysis effort, in practice it is a continuous process that is used whenever the need for validating or refining data concepts or requirements appears advisable. It is included at this point in this paper to emphasize its usefulness in validating the integrated systems context established.

In conducting this step the MIS Task Force gains additional insights into the value of alleviating certain subproblems, learns more about how the core system does or should operate, augments its ability to define and classify problems (see Steps 6 and 7) as well as to structure alternative application concepts in order to alleviate them and, finally, to think more comprehensively about which problems should be alleviated first and the sequence in

EXECUTIVE INFORMATION SYSTEMS	A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT

DATA: COLLECTION-REPRESENTATION-ANALYSIS

SIMPLE

TO

SOPHISTICATED

EXISTING REPORTS
INTERVIEWS
OBSERVATION
QUESTIONNAIRES
SAMPLING

INPUT/OUTPUT MATRICES
FLOW CHARTS
DECISION TABLES
MODELS

DATA REDUCTION & SUMMARIES
STATISTICAL TECHNIQUES
MODELLING & SIMULATION

which the remaining problems should be addressed. The evolutionary development strategy thus can be adjusted to accommodate new requirements identified as MIS capabilities are implemented or to take advantage of more sophisticated technological aids, if applicable, as they become available.

Time and cost constraints, always present, necessitate extreme care on the part of the MIS Task Force in defining the specific problems to be refined as too often valuable time is lost in gathering superfluous data on the entire system, an effort that adds little to the understanding. The goal should be to identify particularly sticky problems such as some of those embedded in the decision-making process and gather additional details on their nature, an effort that is useful in developing a strategy for their time-phased solutions.

In conducting this and previous steps, the MIS Task Force has a range of simple to sophisticated techniques (see opposite Chart) from which to select the appropriate tool. The typical approach* involves collecting data by interviewing people and observing activities about

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*R.H. Gregory and R.L. Van Horn, Automatic Data-Processing Systems; Belmont, California, Wadsworth Publishing Co., 1963.

the events — their type, volume and timing — that lead to the origination of documents, maintenance of files, issuance of reports, processing steps done at each work station (e.g., desk), and flow of documents between stations; collecting sample copies of completed reports; studying the processing operations to learn the how and why of every document that each person receives or issues; organizing the facts obtained into flowcharts, flow lists or other suitable form to trace the path of data from origin, through each stage of communication and processing, into files, and out of files to reports; and, finally, interviewing each user of documents and reports to learn what information he uses in his work and what he thinks he needs.

The input/output matrix cited in the Chart on page 62 represents another helpful technique for compactly portraying the data items used in a system. Not only do such charts help the MIS Task Force to identify the significant data items in the particular system being analyzed, they also help to focus its attention on needlessly redundant items for elimination. Such charts help to design more relevant computer data bases by identifying often-used permanent types of information in a way that makes it easy to pick them out.

Newer and more sophisticated methods for analyzing the decision-making process involve the use of computer-aided modelling (simulation). If data are available and a relevant model can be conceived or tailored from existing applications, this technique provides important insights into what's wrong with the current system* and how to improve it. At some management levels, models of the decision-making process exist; unfortunately, relevant models of the most important decision-making processes (for example, strategic planning) have not yet been developed.**

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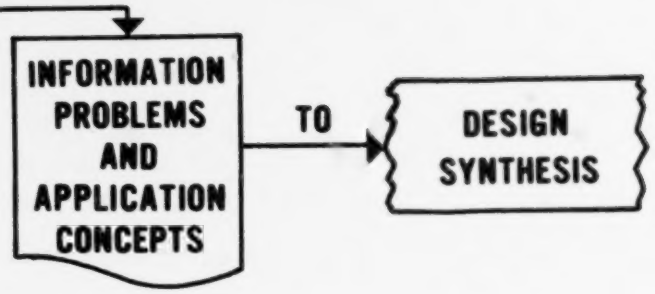
*J. F. Rockart, "Model-Based Systems Analysis: A Methodology and Case Study;" Industrial Management Review, 11, Winter 1970.

**For a discussion of the limitations in the evolution of relevant MIS and management science techniques, see J. A. Evans, "Educational Management Information Systems: Progress and Perspectives;" paper presented at the Conference on Social and Technological Change: Implications for Education, sponsored by the Center for the Advanced Study of Educational Administration and the ERIC Clearinghouse on Educational Administration, December 1969; proceedings to be published in the fall of 1970.

EXECUTIVE INFORMATION SYSTEMS	A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT

RANKING OF PROBLEM AREAS/APPLICATION CONCEPTS

- IMPORTANCE IN RELATION TO ORGANIZATION/MISSION
- URGENCY IN RESPECT TO DISTRICT NEEDS
- AMENABILITY TO AUTOMATION AIDS
- EASE OF INTRODUCTION
  - POLITICAL, ECONOMIC, SOCIAL & SKILL-CONSTRAINTS
  - TECHNOLOGICAL "SHOPPING LIST"
- "BUILDING BLOCKS" FOR FLEXIBLE GROWTH
- RELATIONSHIP TO STATE/OTHER SYSTEMS

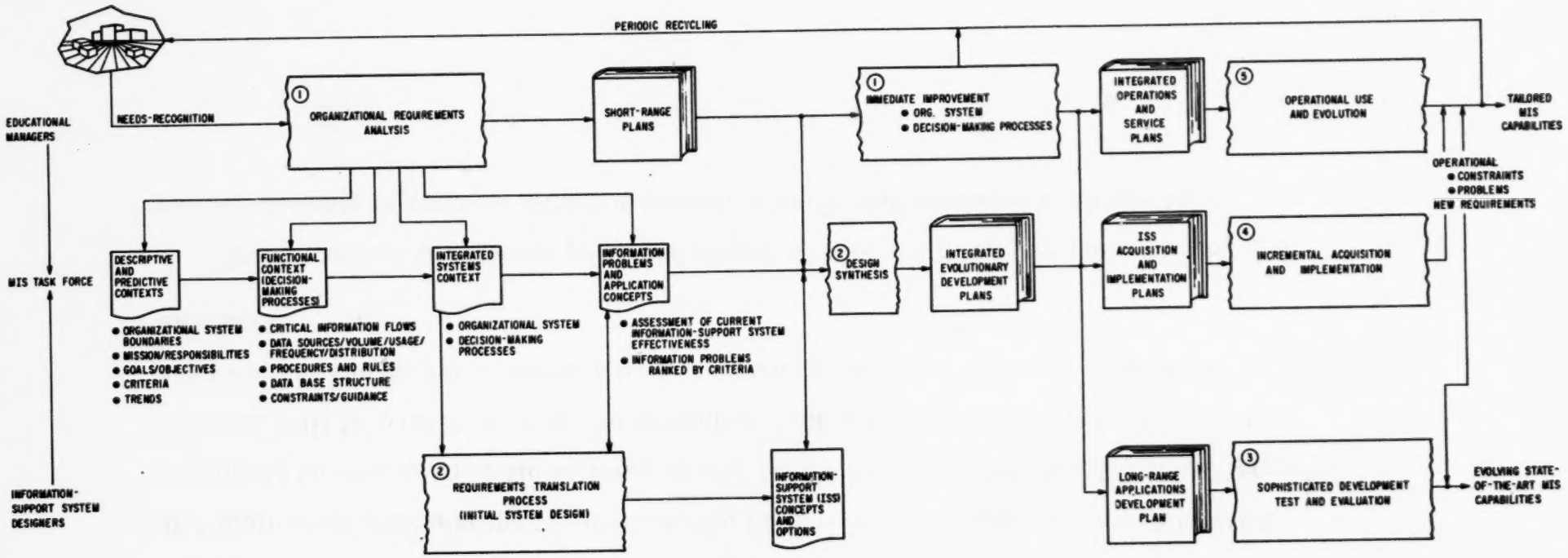


The problems identified as a result of establishing the integrated systems context now can be validated, refined or again recycled for additional data. The criteria used and application concepts that evolved during Step 7 can be expanded to include such important factors as specific building blocks for evolutionary MIS development. More attention will be paid here to the relationship, both political and technological, of the core system and its information-support system to the other systems with which it interacts.

Documentation previously prepared should be updated to reflect the expanded and refined insights in order to avoid mismatch of needs and operational capabilities.

EXECUTIVE INFORMATION SYSTEMS

A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT



Simon,* like Dewey before him,** recognized the critical importance of problem-finding. Never is this need more critical than when contemplating the use of information technology to aid management decision making. The computer represents a valuable and powerful partner if its role is precisely defined but it can be a costly and disruptive re-distributor of knowledge and power which significantly affects the survival of the manager and his organizational system if it is designed to be responsive to ill-defined or irrelevant needs. And the responsibility for explicitly defining such needs falls to the user, in this case the educational manager, not to the system designer. For as Diebold says:

> Truly fruitful results from information handling systems require a fundamental change in approach, an understanding that the best applications come not from the mechanization or streamlining of

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*H.A. Simon, The New Science of Management Decision; New York, Harper & Row, Publishers, 1960.

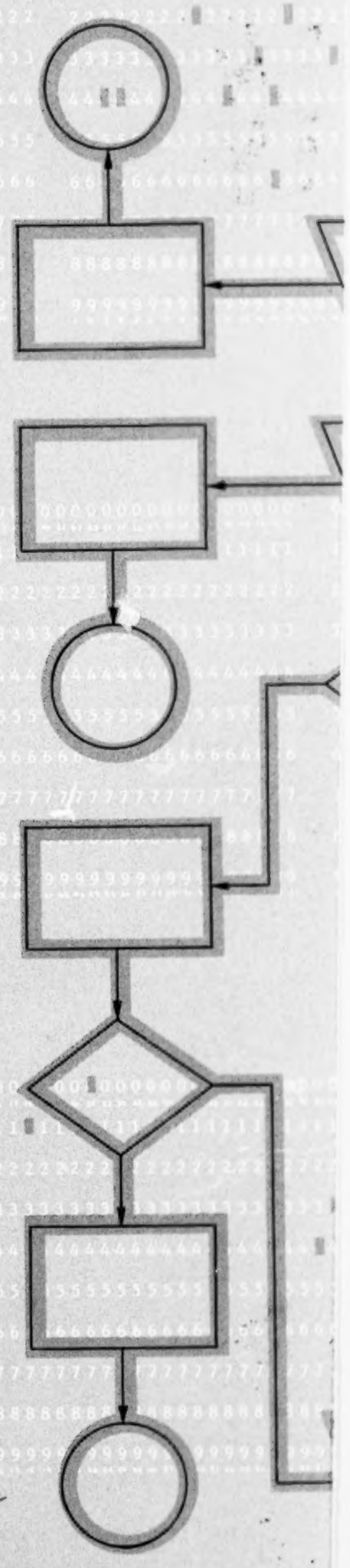
**J. Dewey, How We Think, New York, D.C. Heath & Company, 1910.

> existing procedures but are based on management's willingness to rethink the problems of an entire business in terms of ultimate goals and final products (e.g., educational services). These are not technical problems. They are problems of definition of objectives and assessment of markets, of method, of organization and of attitude.*

Involvement is costly but the value of computer aids properly designed on the basis of an integrated context more than offsets such costs because, by participating, the manager has significantly increased both his understanding of the organization and the probability that the tools will be tailored to his needs.

The framework described in this paper provides a comprehensive outline of the efforts involved in MIS evolutionary development. Its particular focus in this part has been on organizational problem-finding, a subject little discussed in the literature but of critical concern to the manager.

*J. Diebold, Beyond Automation: Management Problems of Exploding Technology; New York, McGraw-Hill Book Co., Inc., 1964.



OPERATION PEP

a state-wide project to prepare educational planners for California

M Burke